

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

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PB Progress Index	Abstract Blue B/R Renewal
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PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing (day/month/year) **28. 12. 00**

Applicant's or agent's file reference
14.0125

IMPORTANT NOTIFICATION

International application No.
PCT/IB99/01724

International filing date (day/month/year)
21/10/1999

Priority date (day/month/year)
03/11/1998

Applicant
SCHLUMBERGER CANADA LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 14.0125	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/IB 99/01724	International filing date (day/month/year) 21/10/1999	(Earliest) Priority Date (day/month/year) 03/11/1998
Applicant SCHLUMBERGER CANADA LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

METHOD AND APPARATUS FOR SEISMIC DATA ACQUISITION IN A LAND- OR TRANSITION ZONE ENVIRONMENT

5. With regard to the abstract,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☒ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

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☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01724

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01V1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 92 12442 A (INST FRANCAIS DU PETROL) 23 July 1992 (1992-07-23)	1-6, 14-16, 21, 23-25, 32-34
A	page 6, line 25 -page 10, line 4; figure 1	7,8,17, 26,35
A	US 4 589 100 A (SAVIT CARL H) 13 May 1986 (1986-05-13)	1,2,6,8, 14,16, 17,21, 25,32, 34,35
	column 1, line 13 - line 68; figures 1,2 column 4, line 37 -column 5, line 7 -/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

22 June 2000

Date of mailing of the international search report

04.07.00

Name and mailing address of the ISA

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Authorized officer

Anderson, A

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01724

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 12577 A (GECO PRAKLA UK LTD ;LAAKE ANDREAS WOLFGANG (GB); AKKOCA ABDULLAH () 26 March 1998 (1998-03-26) cited in the application ---	
A	US 5 276 655 A (J.RIALAN ET AL) 4 January 1994 (1994-01-04) column 4, line 47 -column 5, line 12; claim 1; figure 2 ---	41,61
A	US 5 257 241 A (G.J. HENDERSON ET AL) 26 October 1993 (1993-10-26) column 7, line 39 - line 54; figure 1 column 10, line 23 - line 31; figure 4 -----	41,61

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 99/01724

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

B x III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A method of acquiring seismic data adapted for a land or transition zone environment including placing a location identifier (34) in a particular location, placing a seismic sensor (26) near the location identifier (34), reading the location identifier (34) using a seismic data cable, recording seismic data acquired by the seismic sensor (26) using the seismic data cable, and assigning sensor position coordinates to the seismic data based on measured position coordinates of the location identifier (34). The invention also involves an apparatus adapted for seismic data acquisition in a land or transition zone environment including a location identifier (34), a seismic sensor (26) capable of being placed near the location identifier, a seismic data cable, means for reading the location identifier using the seismic data cable, means for recording seismic data acquired by the seismic sensor (26) using the seismic data cable, and means for assigning sensor position coordinates to the seismic data based on measured position coordinates of the location identifier.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-20, 21-40

2. Claims: 41-60, 61-85

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

IB 99/01724

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9212442	A	23-07-1992	FR 2671197 A DE 69118174 D DE 69118174 T EP 0517896 A NO 303554 B	03-07-1992 25-04-1996 29-08-1996 16-12-1992 27-07-1998
US 4589100	A	13-05-1986	NONE	
WO 9812577	A	26-03-1998	AU 4310497 A EP 0932843 A GB 2331971 A, B GB 2332275 A	14-04-1998 04-08-1999 09-06-1999 16-06-1999
US 5276655	A	04-01-1994	FR 2671112 A CA 2075033 A	03-07-1992 29-06-1992
US 5257241	A	26-10-1993	NONE	

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

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(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 14.0125	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IB99/01724	International filing date (day/month/year) 21/10/1999	Priority date (day/month/year) 03/11/1998
International Patent Classification (IPC) or national classification and IPC G01V1/00		
Applicant SCHLUMBERGER CANADA LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of seven sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26/04/2000	Date of completion of this report 28.12.00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hiltner, K Telephone No. +49 89 2399 2198



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB99/01724

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).):*

Description, pages:

1-25 as originally filed

Claims, No.:

1-45 as received on 21/11/2000 with letter of 21/11/2000

Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB99/01724

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-45
	No: Claims
Inventive step (IS)	Yes: Claims 1-45
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-45
	No: Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IB99/01724

re item V (Reasoned statement..):--

1. There are two independent claims 1 (apparatus) and 21 (method).
Most relevant available prior art is known from D1 = WO 92/ 12 442.

In D1, the data from a remote location identifier (GPS 2,3) is transmitted to the data acquisition station receiver (5), preferably via a cable (page 8, lines 11-13), and stored there in a memory (9) and the data from the geophones Ri is stored in a memory (10). The combined data set is transmitted to the central station (1 in Fig. 1) either over antenna 12 or by cable link 13.

However, the geophones Ri are conventional in D1

By contrast, the invention uses auxiliary positioning devices in order to increase the determination accuracy of the geophones' position.

As best seen in present Fig. 3, there is an airborne acoustic transmission between MAT 30 and SAT 32, the main acoustic transmitter MAT being the positioning device, the secondary acoustic transmitter SAT being the seismic sensor.

No hint at such positioning device is found in D1.

The other documents of the ISR disclose the common prior art of seismic data acquisition and mainly are cited for that part of the orig. filed claims which has been deleted.

For these reasons, the requirements of Art. 33 (2)(3) PCT are considered to be met.

2. It is obvious that an apparatus and a method in the field of seismic data acquisition are industrially applicable, Art. 33(4) PCT.
3. The dependent claims 2-20 and 22-45, perforce, meet the requirements of Art. 33 PCT.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IB99/01724

re item VII (Certain defects...):--

1. Reference signs in the claims would increase their intelligibility, Rule 6 .2 (b) PCT.
2. The prior art according to D1 is not acknowledged in the description, Rule 5.1 (a) (ii) PCT.
3. The method according to the invention on page 6, penultimate paragraph, is not in agreement with independent claim 21, the apparatus according to the invention in the last paragraph is not in agreement with claim 1.

CLAIMS

1. An apparatus adapted for seismic data acquisition in a land or transition zone environment, said apparatus comprising:
 - a positioning device;
 - a seismic sensor, capable of being placed near said positioning device; and
 - means for determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.
2. An apparatus as claimed in Claim 1, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.
3. An apparatus as claimed in Claim 2, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.
4. An apparatus as claimed in either Claim 2 or Claim 3, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.
5. An apparatus as claimed in any one of Claims 1 to 4, in which said airborne acoustic transmission is a spread spectrum acoustic signal.
6. An apparatus as claimed in any one of Claims 1 to 5, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.
7. An apparatus as claimed in any one of Claims 1 to 6, in which said airborne acoustic

transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

8. An apparatus as claimed in any one of Claims 1 to 7, further including a temperature sensor for measuring the temperature of the air near said seismic sensor or said positioning device.
9. An apparatus as claimed in any one of Claims 1 to 8, further including a survey flag and wherein said positioning device is placed near said survey flag.
10. An apparatus as claimed in any one of Claims 1 to 9, in which said positioning device is a first positioning device and further including a second positioning device and means for determining the distance between said second positioning device and said seismic sensor using an airborne acoustic transmission between said second positioning device and said seismic sensor.
11. An apparatus as claimed in Claim 10, further including means for determining the distance between said first positioning device and said second positioning device.
12. An apparatus as claimed in Claim 11, in which said means for determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.
13. An apparatus as claimed in any one of Claims 10 to 12, in which said first positioning device and said second positioning device are connected by a cable.
14. An apparatus as claimed in any one of Claims 10 to 13, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.

15. An apparatus as claimed in any one of Claims 10 to 14, further including means for confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device
16. An apparatus as claimed in any one of Claims 10 to 15, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.
17. An apparatus as claimed in any one of Claims 1 to 16, wherein said seismic sensor is a first seismic sensor and further including additional seismic sensors and means for determining the distance between said additional seismic sensors and said positioning device using airborne acoustic transmissions between said positioning device and said additional seismic sensors.
18. An apparatus as claimed in Claim 17, further including means for calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.
19. An apparatus as claimed in Claim 17, further including means for determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.
20. An apparatus as claimed in any one of Claims 1 to 19, in which said seismic sensor and said positioning device are located at a first seismic station and further including an additional positioning device located at a second seismic station and means for determining the distance between a device located at said first seismic station and a device located at said second seismic station.
21. A method of determining the position of a seismic sensor adapted for seismic data

acquisition in a land or transition zone environment, said method comprising the steps of:

- placing a positioning device in a particular location;
- placing a seismic sensor near said positioning device; and
- determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.

22. A method as claimed in Claim 21, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.
23. A method as claimed in Claim 22, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.
24. A method as claimed in either Claim 22 or Claim 23, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.
25. A method as claimed in any one of Claims 21 to 24, in which said airborne acoustic transmission is a spread spectrum acoustic signal.
26. A method as claimed in any one Claims 21 to 25, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.
27. A method as claimed in any one of Claims 21 to 26, in which said airborne acoustic transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

28. A method as claimed in any one of Claims 21 to 27, further including the step of measuring the temperature of the air near said seismic sensor or said positioning device.
29. A method as claimed in any one of Claims 21 to 28, in which said positioning device is placed near a survey flag.
30. A method as claimed in any one of Claims 21 to 29, in which said positioning device is a first positioning device and further including the step of determining the distance between a second positioning device and said seismic sensor using an airborne acoustic transmission between said second positioning device and said seismic sensor.
31. A method as claimed in Claim 30, further including the step of determining the distance between said first positioning device and said second positioning device.
32. A method as claimed in Claim 31, in which said step of determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.
33. A method as claimed in any one of Claims 30 to 32, in which said first positioning device and said second positioning device are connected by a cable.
34. A method as claimed in any one of Claims 30 to 33, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.
35. A method as claimed in any one of Claims 30 to 34, further including the step of confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device

36. A method as claimed in any one of Claims 30 to 35, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.
37. A method as claimed in any one of Claims 21 to 35, in which said seismic sensor is a first seismic sensor and further including additional seismic sensors and the step of determining the distance between said additional seismic sensors and said positioning device using airborne acoustic transmissions between said positioning device and said additional seismic sensors.
38. A method as claimed in Claim 37, further including the step of calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.
39. A method as claimed in Claim 37, further including the step of determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.
40. A method as claimed in any one of Claims 21 to 39, in which said seismic sensor and said positioning device are located at a first seismic station and further including an additional positioning device located at a second seismic station and the step of determining the distance between a device located at said first seismic station and a device located at said second seismic station.
41. A method as claimed in any one of Claims 21 to 40, further including the steps of recording seismic data acquired by said seismic sensor and assigning sensor position coordinates to said seismic data based on said distance between said seismic sensor and said positioning device.

42. A method as claimed in any one of Claims 21 to 41, further including the step of calculating a deviation between actual seismic sensor position coordinates and planned seismic sensor position coordinates.
43. A method as claimed in Claim 42, further including the step of compensating for said deviation between said actual seismic sensor position coordinates and said planned seismic sensor position coordinates.
44. A method as claimed in Claim 43, in which said compensation step includes mathematically moving a group center of gravity from an actual position to a planned position.
45. A method as claimed in Claim 44, in which said compensation step includes bypassing a digital ground roll removal process.